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First Named Inventor: OUDERKIRK, ANDREW J.

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Group Art Unit 2814

Title: PHOSPHOR BASED LIGHT SOURCES HAVING FRONT ILLUMINATION

BRIEF ON APPEAL

Mail Stop: Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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December 10, 2007

Date

Signed by: Sara N. Zientek

Dear Sir:

This is an appeal from the final Office Action dated June 12, 2007, which finally rejected all pending claims 1-21.

A Notice of Appeal was faxed to the USPTO on September 11, 2007, and was received at the USPTO on the same date. This brief is therefore believed to be timely submitted.

The fee required under 37 CFR § 41.20(b)(2) for filing an appeal brief should be charged to Deposit Account No. 13-3723.

Appellants request the opportunity for a personal appearance before the Board of Appeals to argue the issues of this appeal. The fee for the personal appearance will be timely paid upon receipt of the Examiner's Answer.

Fees

- ☒ Any required fee under 37 CFR § 41.20(b)(2) will be made at the time of submission via EFS-Web. In the event fees are not or cannot be paid at the time of EFS-Web submission, please charge any fees under 37 CFR § 1.17 which may be required to Deposit Account No. 13-3723.
- ☐ Please charge any fees under 37 CFR §§ 37 CFR § 41.20(b)(2)1.16 and 1.17 which may be required to Deposit Account No. 13-3723. (One copy of this sheet marked duplicate is enclosed.)
- ☒ Please charge any additional fees associated with the prosecution of this application to Deposit Account No. 13-3723. This authorization includes the fee for any necessary extension of time under 37 CFR § 1.136(a). To the extent any such extension should become necessary, it is hereby requested.
- ☒ Please credit any overpayment to the same deposit account.

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REAL PARTY IN INTEREST

The real party in interest is 3M Company (formerly known as Minnesota Mining and Manufacturing Company) of St. Paul, Minnesota and its affiliate 3M Innovative Properties Company of St. Paul, Minnesota.

RELATED APPEALS AND INTERFERENCES

Appellants are unaware of any related appeals or interferences.

STATUS OF CLAIMS

Claims 1-21 are pending. All of these claims stand rejected, and all are being appealed.

STATUS OF AMENDMENTS

No amendments have been filed after the final Office Action of June 12, 2007.

SUMMARY OF CLAIMED SUBJECT MATTER**Claim 1**

The subject matter of independent claim 1 is a light source that includes an LED capable of emitting light, a layer of phosphor material, and interference reflector means. The layer of phosphor material is positioned to receive excitation light from the LED, and it emits visible light when illuminated with the excitation light. The interference reflector means performs two functions: (1) it reflects at least some light emitted by the LED that has not passed through the layer of phosphor material, onto the layer of phosphor material, and (2) it transmits at least some visible light emitted by the phosphor.

Support for the various elements of claim 1 can be found throughout the specification and drawings. An "LED capable of emitting light" is described for example at page 2 lines 5-8, page 3 lines 4-19, page 15 lines 13-17, and is shown in FIGS. 1 and 5-12 (element 12), FIG. 13 (element 212), FIG. 14 (element 312), and FIG. 15 (element 412). A layer of phosphor material is shown in at least FIGS. 1, 2 (element 22), 5 (element 42), 6 and 7 (element 52), 8 (element 72), 9 (element 82), 10 (element 92), 11 (element 102), 13 (element 222), 14 (element 322), and 15 (element 422), and described in various places such as p. 3 lines 14-26, p. 9 lines 21-26, p. 13 lines 6-13, p. 14 line 22 to p. 15 line 10, and p. 19 line 21 to p. 21 line 11. The layer of phosphor material is a layer that includes phosphor material, such as phosphor material in the form of phosphor particles that are retained by a binder material (see p. 15, lines 1-4).

With regard to the interference reflector means for performing the two functions mentioned above, the structure for performing those functions and the functions themselves are shown and described in various places, including: page 3 lines 16-18 (mentioning the reflector's ability to reflect UV excitation light (emitted by the LED) and transmit visible light (emitted by the phosphor)), page 3 line 27 to p. 4 line 5, p. 4 line 17 to p. 5 line 2, p. 7 line 11 to p. 10 line 20, and p. 16 line 8 to p. 18 line 2 (using the term "interference reflector" and describing reflector constructions that can selectively reflect the LED excitation light and transmit the phosphor-emitted light). Arrangements in which the interference reflector means is performing both functions, including specifically reflecting onto the layer of phosphor material at least some light emitted by the LED *that has not passed through the layer of phosphor material*, are shown and described in connection with FIGS. 9, 10, 13, and 15. The embodiment of FIG. 9, discussed

further below, depicts a reflector 86 reflecting onto a layer of phosphor material 82 light emitted by an LED 12 that has not passed through the layer of phosphor material. The specification teaches at p. 13 lines 3-5 that the reflector 86 also transmits light emitted by the phosphor layer.

Claim 2

The subject matter of independent claim 2 is a light source that includes a layer of phosphor material, an LED capable of emitting light that excites the phosphor material, and an interference reflector. The interference reflector is positioned to reflect at least some light emitted by the LED that has not passed through the layer of phosphor material, onto the layer of phosphor material.

As with claim 1, support for the various elements of claim 2 can be found throughout the specification and drawings. An "LED capable of emitting light that excites the phosphor material" is described for example at page 2 lines 5-8, page 3 lines 4-19, page 15 lines 13-17, and is shown in FIGS. 1 and 5-12 (element 12), in FIG. 13 (element 212), in FIG. 14 (element 312), and in FIG. 15 (element 412). A layer of phosphor material is shown in at least FIGS. 1, 2 (element 22), 5 (element 42), 6 and 7 (element 52), 8 (element 72), 9 (element 82), 10 (element 92), 11 (element 102), 13 (element 222), 14 (element 322), and 15 (element 422), and described in various places such as p. 3 lines 14-26, p. 9 lines 21-26, p. 13 lines 6-13, p. 14 line 22 to p. 15 line 10, and p. 19 line 21 to p. 21 line 11. Interference reflectors are shown and described in various places, including: page 3 lines 16-18, page 3 line 27 to p. 4 line 5, p. 4 line 17 to p. 5 line 2, p. 7 line 11 to p. 10 line 20, and p. 16 line 8 to p. 18 line 2 (using the term "interference reflector" and describing reflector constructions that can selectively reflect the LED excitation light and transmit the phosphor-emitted light). Arrangements in which the interference reflector is positioned to reflect at least some light emitted by the LED *that has not passed through the layer of phosphor material* onto the layer of phosphor material, are shown and described in connection with FIGS. 9, 10, 13, and 15.

The language in claims 1 and 2 referring to reflecting onto the layer of phosphor material at least some light emitted by the LED "that has not passed through the layer of phosphor material" is closely related to disclosed light source embodiments that use a front or top surface illumination technique. In this technique, an interference reflector is used to directly illuminate the layer of phosphor material (at least partially) from the front or top, rather than solely from the

back or bottom of the phosphor layer. This can be understood by comparing the light source of Appellants' FIGS. 1-2 with that of FIGS. 9, 10, 13, and 15.

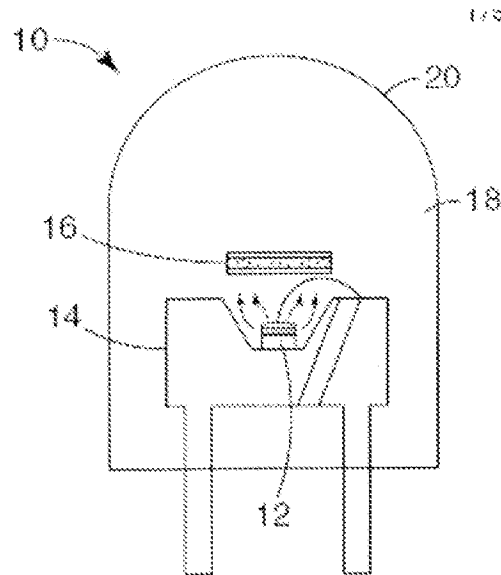
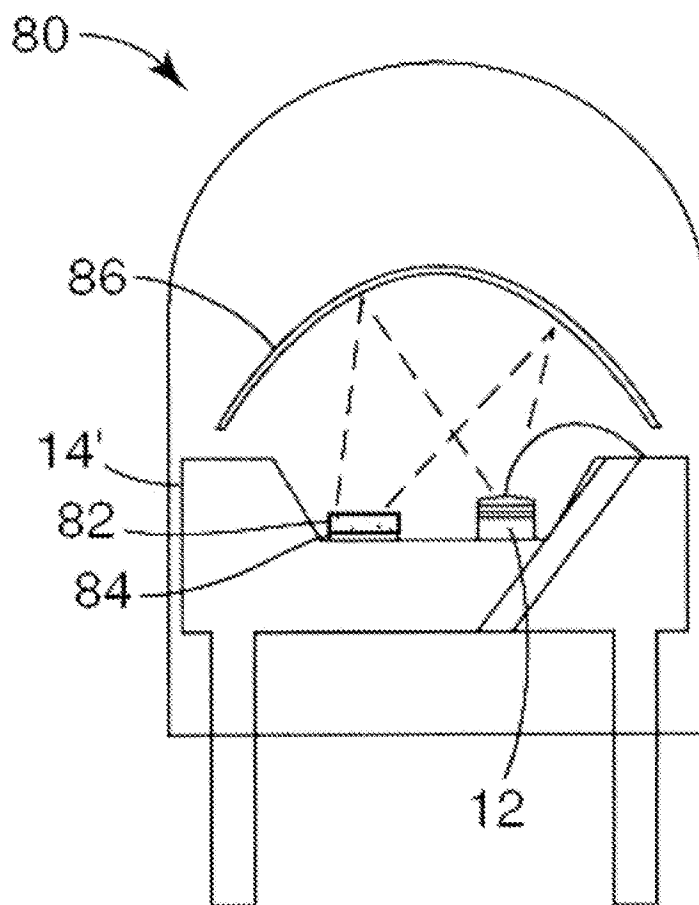


FIG. 1



FIG. 2

In FIGS 1-2, long-pass reflector 24 (an interference reflector) reflects light from the LED light source onto the phosphor layer 22, but it only reflects LED light that has already passed through the phosphor layer. Thus, direct illumination from the LED is exclusively from the back or bottom surface of the phosphor layer (through short-pass reflector 26).

**FIG. 9**

In contrast, long-pass filter 86 of FIG. 9 (also an interference reflector) is positioned to receive light from the LED that has not passed through the phosphor layer, and reflect that light directly onto the front or top surface of the phosphor layer 82. Thus, the layer of phosphor material is directly illuminated from the front or top. Such an arrangement is feasible because the interference reflector (such as a long-pass filter) has wavelength selective properties such that it can not only reflect the LED excitation light, but also transmit the (typically longer wavelength) light emitted by the phosphor layer, so that the light emitted by the phosphor layer is not trapped within the light source. Advantages of the front illumination technique are discussed in the specification at p. 13 lines 6-13.

Claim 3

The subject matter of multiply dependent claim 3 is a light source having the features of either claim 1 or claim 2, and wherein the layer of phosphor has a major surface from which light is emitted toward an output end of the light source, and wherein the light emitted by the LED that has not passed through the layer of phosphor material is reflected onto the major surface of the layer of phosphor material. This additional feature is shown in FIGS. 9, 10, 13, and 15. In FIG. 9, for example, discussed at p. 12 line 21 to p. 13 line 13, the phosphor layer 82 has an upper major surface from which light is emitted toward the rounded front end of the light source body. As explained above, the long-pass filter 86 reflects LED light that has not passed through the layer of phosphor material onto that upper major surface.

Claim 12

The subject matter of dependent claim 12 is a light source having the features of claim 2, and wherein the layer of phosphor material is co-planar with the LED. This feature is shown for example in FIGS. 9 and 13, and discussed at p. 12 lines 25-27 and p. 24 line 2 to p. 25 line 1.

Claim 14

The subject matter of dependent claim 14 is a light source having the features of claim 2, and wherein the layer of phosphor material is a discontinuous layer of phosphor material. This feature is described for example at p. 19 line 21 to p. 20 line 4, and p. 26 lines 7-16.

Claim 20

The subject matter of dependent claim 20 is a light source having the features of claim 2, and wherein the reflector comprises alternating layers of a first and second thermoplastic polymer wherein at least some of the layers are birefringent. This feature is described for example at p. 4 lines 17-22, and p. 23 line 26 to p. 24 line 15.

GROUND OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1-5, 8 and 11-12 have been finally rejected under 35 USC § 102(b) as being anticipated by U.S. Patent 5,813,752 (Singer et al.).

Claims 6, 7, 9 and 13 have been finally rejected under 35 USC § 103(a) as being unpatentable over U.S. Patent 5,813,752 (Singer et al.) in view of U.S. Patent 6,864,554 (Lin et al.).

Claim 10 has been finally rejected under 35 USC § 103(a) as being unpatentable over U.S. Patent 5,813,752 (Singer et al.) in view of U.S. Patent U.S. 5,959,316 (Lowery).

Claim 14-19 and 21 have been finally rejected under 35 USC § 103(a) as being unpatentable over U.S. Patent 5,813,752 (Singer et al.) in view of U.S. Patent 6,717,348 (Takahashi).

Claim 20 has been finally rejected under 35 USC § 103(a) as being unpatentable over U.S. Patent 5,813,752 (Singer et al.) in view of U.S. Patent 6,652,996 (Steklenski et al.).

The issues presented for review are:

1. whether claims 1-5, 8 and 11-12 are novel over Lowery;
2. whether claims 6, 7, 9 and 13 are patentably nonobvious over Singer et al. in view of Lin;
3. whether claim 10 is patentably nonobvious over Singer et al. in view of Lowery;
4. whether claims 14-19 and 21 are patentably nonobvious over Singer et al. in view of Takahashi; and
5. whether claim 20 is patentably nonobvious over Singer et al. in view of Steklenski.

ARGUMENT

1. Claims 1-5, 8 and 11-12 are novel over Lowery

Claim 1

In order to anticipate a claim, a reference must teach every element of the claim. Claim 1 recites a light source that includes, among other things, interference reflector means for reflecting a first light component ("at least some light emitted by the LED that has not passed through the layer of phosphor material") onto the layer of phosphor material and transmitting a second light component ("at least some visible light emitted by the phosphor"). Singer teaches nothing like this.

With respect to pending claims 1-4, the Examiner alleges Singer teaches: an LED capable of emitting light (Fig. 3); a layer of phosphor material having a major surface positioned to receive excitation light and emitting visible light when illuminated with the excitation light (column 4, line 47 and Fig. 3); and interference reflector means positioned to reflect at least some light emitted by the LED that has not passed through the layer of phosphor material, onto the major surface layer of phosphor material and transmitting at least some visible light emitted by the phosphor (column 4, lines 51-54 and Fig. 3). The Examiner further contends that "some of the light emitted passes through the phosphor layer without converting into visible. Singer et al. install a long-wave pass (LWP) filter 50, which is made of multi-layered dielectric stacks to reflect the un-converted light back to the phosphor layer 48 and transmits the converted light through the LWP filter 50 (col. 4, lines 51-57 and fig. 3). Other citations to Singer are made regarding rejected claims 5, 8, 11 and 12. None of these rejections can be sustained.

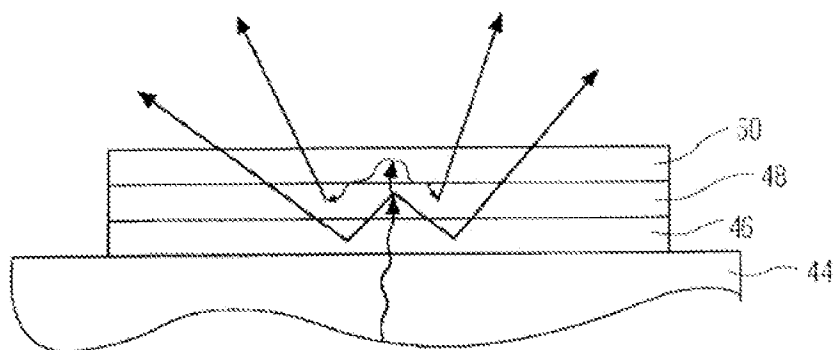


FIG. 3

The Examiner alleges that Singer teaches both of these functions at column 4, lines 51-54, and in FIG. 3, but that is not correct. The cited passage describes the functions of Singer's LWP filter 50, shown in Singer's Figure 3 immediately atop his phosphor layer 48. The passage states, inter alia, that the LWP filter "reflect[s] UV light which is not absorbed by the phosphor grains back to the phosphor for another opportunity to be absorbed" (emphasis added). This is consistent with Singer's Figure 3, where some UV light (indicated by the wavy arrow) generated by the LED 44 is shown passing through the phosphor layer 48 — because it has not been absorbed by the phosphor grains residing in the phosphor layer — and then being reflected by the LWP filter 50.

In making the rejection, the Examiner fails to distinguish between the concepts of not being absorbed by the phosphor grains of a layer of phosphor layer discussed in Singer, and "not pass[ing] through the layer of phosphor material," recited in claim 1. Singer's LWP filter 50 reflects some light emitted by his LED 44 onto his phosphor layer 48, but all of this light passes through the phosphor layer 48 as can plainly be seen in Singer's Figure 3. Indeed, it is because of this that Singer must clarify for the reader that some of the LED light entering the phosphor layer is not absorbed by the phosphor grains — and for this reason it can pass through the phosphor layer on its way to the LWP filter. Since no portion of the UV light reflected by the LWP filter 50 onto the phosphor layer 48 "has not passed through the layer of phosphor material," the LWP filter 50 does not satisfy function (1) above and thus cannot be the "interference reflector means" set forth in claim 1. Hence, Singer fails to teach all elements of claim 1, and the rejection should be withdrawn.

Claims 2

Concerning pending claim 2, Singer fails to disclose every limitation of claim 2 for at least the same reason discussed above related to claim 1. Singer fails to disclose an "interference reflector" that reflects "at least some light emitted by the LED that has not passed through the layer of phosphor material, onto the layer of phosphor material." Singer discloses with reference to Figure 3 passing all of the light generated by the LED 44 through the layer 46 into the phosphor layer 48. None of the light generated by the LED 44 is reflected back to the phosphor layer 48 by the LWP filter 50 without first having passed through the phosphor layer. Therefore, Singer fails to disclose every limitation of claim 2 and the claims that depend from it. The rejection of claim 2 should therefore be withdrawn.

Claim 3

Pending claim 3 depends from either claim 1 or claim 2, and recites that the layer of phosphor has a major surface from which light is emitted toward an output end of the light source. Claim 3 further recites that the light emitted by the LED that has not passed through the layer of phosphor material is reflected onto that major surface. The Office Action fails to address the specific structure and arrangement of features required in order to meet the limitations of claim 3. Claim 3 specifies a particular major surface of the phosphor material, namely, one from which light is emitted toward an output end of the light source. For the embodiment of Singer's Figure 3, that would be the uppermost (flat) surface of the phosphor layer 48. However, claim 3 further specifies that a particular light component is reflected onto that major surface. That light component is entirely absent from the teachings of Singer, specifically the embodiment of Figure 3 of Singer. That particular light component is the light emitted by the LED that has not passed through the layer of phosphor material and is then reflected onto the major surface of the phosphor layer by the interference reflector means (see claim 1) or the interference reflector (see claim 2). Singer fails to disclose a light component that does not first pass into or through the phosphor layer 48 before being reflected by the LWP filter 50 (see above discussion related to claims 1 and 2). Therefore, Singer fails to disclose every limitation of claim 3 for this additional reason.

The remaining claim rejections under 35 U.S.C. §102(b) cannot be sustained at least because claims 4, 5, 8, 11 and 12 each depend directly from claim 2, and the limitations of claim 2 are not disclosed by Singer as discussed above. Applicants request withdrawal of the rejection of dependent claims 4, 5, 8, 11 and 12. Applicant does not otherwise concede the correctness of these rejections as they relate to claims 4, 5, 8, 11 and 12.

Claim 12

Claim 12 depends directly from claim 2 and further specifies that the layer of phosphor material is co-planar with the LED. This additional feature cannot be found in Singer. The final Office Action states that "Singer discloses the reflector 50 has a planar shape (fig. 3)". This statement does not appear to address the spatial relationship (i.e., co-planar) between the phosphor material and the LED, and thus should be reversed. Further, FIG. 3 of Singer discloses a layer of phosphor material 48 that is spaced apart from the LED 44 by an intervening layer 46. The features 48 and 44 clearly are not arranged in the same plane so as to be "co-planar" with each other.

2. Claims 6, 7, 9 and 13 are patentably nonobvious over Singer et al. in view of Lin

The limitations of claim 2 are not disclosed or otherwise rendered obvious by Singer for at least those reasons discussed above. Nothing in Lin, or in any proper combination of Singer and Lin, remedies the deficiencies of Singer as it relates to claim 2. Therefore, claims 6, 7, 9 and 13 are allowable for at least the reason they are dependent upon an allowable base claim. Appellants do not otherwise concede the correctness of this rejection.

3. Claim 10 is patentably nonobvious over Singer et al. in view of Lowery

The limitations of claim 2 are not disclosed or otherwise rendered obvious by Singer for at least those reasons discussed above. Nothing in Lowery, or in any proper combination of Singer and Lowery, remedies the deficiencies of Singer as it relates to claim 2. Therefore, claim 10 is allowable for at least the reason it is dependent upon an allowable base claim. Appellants do not otherwise concede the correctness of this rejection.

4. Claims 14-19, and 21 are patentably nonobvious over Singer et al. in view of Takahashi**Claims 14-19 and 21**

Claim 14 depends directly from claim 2 and claims 15-19 depend directly or indirectly from claim 14. Claim 14 further specifies that the layer of phosphor material is a discontinuous layer of phosphor material. The Examiner concedes that Singer does not disclose the layer of phosphor material is discontinuous layer of phosphor material. Takahashi and Lowery are directed to substantially different end-products: Lowery to a discrete semiconductor LED device (see col. 1 lines 1-8 of Lowery, and the figures), and Takahashi to an entire display apparatus (see col. 1 lines 1-11 of Takahashi, and the figures), of which an LED light source would be a small component. The phosphor dots 81, 82, 83 of Takahashi are discussed specifically in connection with "a color display apparatus", see col. 5 lines 27-28. One of ordinary skill in the art would have no motivation or incentive to transfer these display-related features of Takahashi into the discrete LED devices of Singer. The rejection of claim 14 should be reversed.

The rejection should also be reversed because claim 14 includes the limitation from claim 2 of "an interference reflector positioned to reflect at least some light emitted by the LED that has not passed through the layer of phosphor material, onto the layer of phosphor material", explained in detail above. This feature is nowhere to be found in either Singer or Takahashi.

Claims 15-19 and 21 include all the limitations of claim 14, and are patentable for at least the same reasons. Appellants do not otherwise concede the correctness of this rejection as it relates to any of claims 15-19 and 21, which have not been argued individually.

4. Claim 20 is patentably nonobvious over Singer et al. in view of Steklenski.

Claim 20 depends directly from claim 2, and further specifies that the reflector comprises alternating layers of a first and second thermoplastic polymer wherein at least some of the layers are birefringent. The Examiner reasons in the final Office Action that Singer and Steklenski et al. have substantially the same environment of a phosphor layer with a reflector, and therefore it would have been obvious "to modify Singer's device with the teaching of Steklenski et al. to provide a polymeric multi-layer reflector in order to provide a uniform reflection across visible wavelength." Singer and Steklenski are directed to substantially different end-products: Singer

to a discrete semiconductor LED device, and Steklenski to a radiographic phosphor panel used in imaging from X-radiation (see col. 1 lines 1-14 of Steklenski, and the figures), which appears to have nothing to do with LED light sources. In view of the very different subject matter of these references, Applicants submit that one of ordinary skill working in the field of LED light sources would have no motivation to consult Steklenski, and one of ordinary skill working in the field of radiographic phosphor panels would have no motivation to consult Singer.

Although Steklenski describes certain polymeric multilayer interference reflectors, the only rationale given to modify Singer with the teachings of Steklenski is "in order to provide a uniform reflection across visible wavelength." But Singer, the primary reference, provides no indication that such a feature is desirable, or on the other hand that such a feature is lacking from its disclosed embodiments to create a motivation by one of ordinary skill to make such a combination of features. In that regard, Steklenski teaches that "not just any polymeric multi-layer reflector can be used in the practice of this invention," and that "an essential feature of the present invention is the use of polymeric multi-layer reflectors that reflect most light striking them at 'high incident angles' and transmit and absorb most light striking them at 'low incident angles'." (Col. 4 lines 40-54 of Steklenski.) The Examiner has provided no evidence that such a feature would be acceptable, much less beneficial, in the invention of Singer. Therefore, the rejection of claim 20 should be reversed.

The rejection should also be reversed because claim 20 includes the limitation from claim 2 of "an interference reflector positioned to reflect at least some light emitted by the LED that has not passed through the layer of phosphor material, onto the layer of phosphor material," explained in detail above. This feature is nowhere to be found in either Singer or Steklenski.

Conclusion

Appellants' claims 1-21 are patentable over the applied references. Appellants earnestly solicit a favorable decision from the Board on each of the issues presented.

Please charge any additional fees or credit any overpayment to Deposit Account No. 13-3723.

Respectfully submitted,

December 10, 2007
Date

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CLAIMS APPENDIX

1. A light source, comprising:
an LED capable of emitting light;
a layer of phosphor material positioned to receive excitation light and emitting visible light when illuminated with the excitation light; and
interference reflector means for reflecting at least some light emitted by the LED that has not passed through the layer of phosphor material, onto the layer of phosphor material and transmitting at least some visible light emitted by the phosphor.
2. A light source, comprising:
a layer of phosphor material;
an LED capable of emitting light that excites the phosphor material; and
an interference reflector positioned to reflect at least some light emitted by the LED that has not passed through the layer of phosphor material, onto the layer of phosphor material.
3. The light source according to claim 1 or 2, wherein the layer of phosphor has a major surface from which light is emitted toward an output end of the light source, and wherein the light emitted by the LED that has not passed through the layer of phosphor material is reflected onto the major surface of the layer of phosphor material.
4. The light source according to claim 2, wherein the reflector substantially reflects light emitted by the LED and substantially transmits light emitted by the phosphor material.
5. The light source according to claim 2, wherein the reflector has a planar shape.
6. The light source according to claim 2, wherein the reflector has a non-planar shape.
7. The light source according to claim 6, wherein the non-planar shape is substantially an ellipsoid, and wherein the LED and the layer of phosphor material are disposed at foci of the ellipsoid.

8. The light source according to claim 2, wherein a first portion of the light emitted by the LED is reflected by the reflector onto a major surface of the layer of phosphor material, and a second portion of the light emitted by the LED impinges on a second major surface of the layer of phosphor material opposed to the first major surface.
9. The light source according to claim 2, wherein the reflector has the shape of a surface of revolution.
10. The light source according to claim 2, wherein the layer of phosphor material surrounds the LED.
11. The light source according to claim 2, wherein the layer of phosphor material is segmented into distinct color regions.
12. The light source according to claim 2, wherein the layer of phosphor material is co-planar with the LED.
13. The light source according to claim 2, wherein the layer of phosphor material is not co-planar with the LED.
14. The light source according to claim 2, wherein the layer of phosphor material is a discontinuous layer of phosphor material.
15. The light source according to claim 14, wherein the discontinuous layer of phosphor material is a plurality of lines of phosphor material or a pattern of phosphor material.
16. The light source according to claim 14, wherein the discontinuous layer of phosphor material comprises a plurality of dots of phosphor material.

17. The light source according to claim 16, wherein the plurality of dots of phosphor material each have an area of less than 10000 microns².

18. The light source according to claim 16, wherein the plurality of dots comprise phosphor material that emits more than one color when illuminated with the excitation light.

19. The light source according to claim 16, wherein the plurality of dots comprise phosphor material that emits red, green and blue light when illuminated with the excitation light.

20. The light source according to claim 2, wherein the reflector comprises alternating layers of a first and second thermoplastic polymer wherein at least some of the layers are birefringent.

21. The light source according to claim 18, wherein at least a first phosphor dot emits light at a first wavelength and a second phosphor dot emits light at a second wavelength different than the first wavelength.

EVIDENCE APPENDIX

None.

RELATED PROCEEDINGS APPENDIX

None.